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INCORPORATING CAREER DEVELOPMENT SKILLS INTO THE STEM CLASSROOM WITH FLIPPED METHODS

Lawrence O. Flowers

Ph.D., Livingstone College, 701 West Monroe Street, Salisbury, NC 28144 - United States.

ABSTRACT

Career development is a lifelong process encompassing many factors and stages essential to achieving occupational aspirations. In flipped classrooms, students watch instructional videos as homework and engage in concept exploration and problem-solving activities in class. A surge in the utilization of the flipped classroom strategy has resulted in an increase in pedagogical research in which investigators employ mixed methods research designs to explore student attitudes and learning outcomes. While many empirical studies have been done to clarify the effects of flipped classrooms on student learning in various disciplines including science, technology, engineering, and mathematics (STEM) fields, very few studies have been conducted to evaluate the use of the flipped classroom model to enhance college students' career development skills. The purpose of this scalable pilot qualitative research study is to investigate STEM student perceptions of utilizing the flipped classroom approach to inculcate critical skills required to enter the workforce. Qualitative data analysis revealed that implementation of the flipped classroom format improved students' understanding and application of STEM job interview techniques. Results also demonstrate that over 90% of the respondents believe that flipped classroom methods would serve as an effective instructional strategy to enhance comprehension of additional career development skills.

KEYWORDS: flipped classroom, social cognitive career theory, career development skills, workforce, STEMployable.

INTRODUCTION:

It is widely known that a staggering number of jobs related to science, technology, engineering, and mathematics (STEM) will be available in the next decade according to occupational employment forecasts. STEM jobs are particularly desirable compared to non-STEM professions because on average they offer higher wages and are subject to lower unemployment rates (Langdon, McKittrick, Beede, Khan, & Doms, 2011). There have been numerous national efforts to improve student preparation for STEM employment as well as to increase diversity in science and engineering careers. However, despite substantial funding and well-intentioned intervention programs over the last decade, occupational data provides evidence that workforce readiness and diversity goals are not being met and that much work needs to be done.

It is also well understood that increasing the number of college graduates with advanced degrees in STEM disciplines will enhance the nation's economic and scientific competitiveness. Moreover, the intellectual and innovative capital that results from a highly skilled populace will help to preserve our preeminent standing in the international economy. Ensuring that college graduates are prepared to enter a STEM field will require a greater emphasis on career development skills and technical job skills training at the undergraduate level. Employing innovative pedagogical methods such as flipped classroom techniques and inquiry-based learning may be instrumental in improving student engagement and enhancing the learning gains of vital STEM industry-based skills (Love, Hodge, Corritore, & Ernst, 2015). This article explores the use of flipped teaching methods to achieve career-focused learning outcomes in college.

Career Development:

Career development is a continual process consisting of several stages including growth, exploration, establishment, maintenance, and disengagement designed to facilitate professional satisfaction and economic prosperity (Super, 1990). Ensuring student preparation for the workforce is a major objective of STEM educators in the 21st century and encompasses existing standards established by governing bodies tasked with improving outcomes at colleges and universities in the United States (Association of American Colleges and Universities, 2007). Preparing qualified students for STEM employment must involve the use of evidence-based pedagogical strategies that enhance retention of discipline-specific content and utilization of career development skills. Career and technical education programs support the contention that authentic learning experiences offer opportunities for students to learn skills paramount to the workplace (Clark, Threeton, & Ewing, 2010).

Improving student employment outcomes is paramount to all colleges and universities. Unfortunately, many STEM departments do not adequately engage in sustainable efforts to ensure that students have acquired compulsory STEM career development skills before graduation. Colleges and universities must effectively teach students how to weave their content knowledge into important career-related documents (e.g., cover letter and resumes) as well as how to utilize scientific communication skills to ensure successful job interviews in their field of interest. The concern for inclusion of targeted career development skills in STEM educational environments has become more compulsory in recent years due to national reports that suggest that millions of STEM jobs will go unfilled in part due to the lack of preparedness of potential job candidates.

The term STEMployable provides an operational definition of student career-related professional outcomes. STEMployable is a straightforward term that describes the skills and knowledge that all graduates should possess to meet the requirements and challenges of the international job market. STEMployable skills are a combination of academic, research, critical thinking, and professional etiquette skills required by today's employers (Flowers, 2017). STEMployable skills refer to the ability to construct a quality resume/cover letter, explore career options, communicate effectively, apply course content and technology to solve real-world problems, and prepare for STEM job interviews. The term STEMployable also provides a transformative, user-friendly nomenclature and an intuitive conceptual framework for institutions of higher learning to develop and implement meaningful strategies to prepare students for the world of work following commencement proceedings.

STEM course developers are advised to incorporate components from the National Career Development Guidelines (NCDG), published by the National Career Development Association, into STEM courses. The NCDG provides a framework consisting of three essential career development domains (e.g., personal social development, educational achievement and lifelong learning, and career management) that may assist faculty in the construction of career development course objectives, departmental outcomes, and classroom strategies (National Career Development Association, 2009). Numerous research studies have shown that career development activities involving resume writing skills and interview workshops are necessary to adequately prepare students for the job market (Reddan, 2008). Recently, it was suggested that college faculty should integrate online career management activities in the STEM curriculum as a mechanism to mediate compliance to career-related program learning outcomes (Flowers, 2017; Flowers & Flowers, 2013).

Flipped Learning:

The flipped classroom or inverted classroom is a teaching method in which student exposure and seminal acquisition of course content are performed at home while class time is primarily reserved for student-centered activities to promote comprehension and application of content knowledge (Rabidoux & Rottmann, 2018; Schmidt & Ralph, 2016; Siegel, 2014). The flipped classroom approach is an active learning-based teaching strategy that incorporates technology to disseminate course content via video and content management systems. Unlike traditional classrooms in which the lion's share of classroom time is spent lecturing and focusing on lower-order thinking skills, flipped classrooms spend more class time focusing on higher-order thinking skills (Anderson et al., 2001). The flipped learning environment offers a potentially advantageous practice to improve STEM undergraduate education. Flipped classrooms provide an opportunity for faculty to structure actual classroom time with real-world activities.

It should also be noted that implementing a flipped classroom strategy requires a great deal of preparation time. Constructing quality videos and planning interactive in-class activities is time-consuming. Adequate planning and evaluation time should be appropriated when considering flipped learning modules. The design of career development lesson plans should involve input from the career services staff on your campus as well as guidance from human resource personnel or current employees at STEM-based companies. The latter will ensure that

the information disseminated to students is pertinent and consistent with the contemporary work environment. This basic empirical exploration is designed to raise awareness of the benefits of utilizing flipped pedagogical techniques to teach skills that may improve occupational outcomes. Flipped classroom activities may include virtual laboratories, debates, educational games, experiments, 5-minute lectures, problem-solving exercises, student oral presentations, quiz bowls, role-playing exercises, case studies, webinars, group discussions, collaborative learning, demonstrations, and content videos (Herreid & Schiller, 2013; Prud'homme-Généreux, Schiller, Wild, & Herreid, 2017). Popularized by Bergmann and Sams (2009), flipped classrooms integrate learner-centered classroom techniques and incorporate online videos that students can access using local and mobile devices. While the flipped classroom environment is obviously ideal for small to medium-sized classrooms, Eichler and Peeples (2016) demonstrated that flipped classrooms could also be effective for large enrollment STEM classes (e.g., 250-500 students). Analysis of the effects of incorporating flipped modules in a large enrollment general chemistry course showed a statistically significant improvement in student grade point averages compared to a non-flipped class.

An increase in the utilization of flipped classrooms at different educational levels has led to inquiries regarding the efficacy of flipped environments to produce beneficial learning gains. Thus, STEM education literature is legion with reports that explore the effects of the flipped classroom on academic performance. Data from flipped research studies suggest that overall flipped instructional strategies appear to play a beneficial role in science student development (Entezari & Javdan, 2016; Heyborne & Perrett, 2016; McLean, Attardi, Faden, & Goldszmidt, 2016; Ojennus, 2016) and mastery of content (Cheng, Ka Ho Lee, Chang, & Yang, 2017). Not surprisingly, data regarding the use of flipped classrooms in STEM courses are mixed. Clark, Kaw, and Besterfield-Sacre (2016) demonstrated that STEM students preferred the blended classroom, which is an amalgam of technology-mediated instructional activities and traditional teaching approaches, over flipped and semi-flipped classrooms. From an implementation perspective, the major drawback to the flipped approach is the reliance on technology. Faculty must ensure that students have the capabilities to view the course information in remote settings when using flipped techniques in their courses.

A deeper exploration of the literature revealed a limited number of scholarly articles that explore the use of flipped teaching strategies to help undergraduates learn fundamental career development techniques. Thus, the purpose of this inquiry is to determine the effectiveness of the flipped classroom model to improve college students' STEM career development skills. Moreover, in addition to verifying efficacy, this study was also performed to determine whether the flipped classroom approach was sufficient to positively affect students' understanding of important STEM career development skills. Knowledge acquisition and efficacy were selected in this seminal study because these two factors are vital when evaluating pedagogical impact (Canelas, Hill, & Novicki, 2017; Ojennus, 2016; Patrick, Howell, & Wischusen, 2016; Stanford, Rocheleau, Smith, & Mohan, 2017). It was hypothesized that incorporation of flipped classroom techniques in a STEM career development program would have a beneficial effect on student comprehension of career development skills. The current work provides seminal observations regarding the significance of employing flipped classroom methods to enhance the career development skills of STEM majors. While this study provides a much needed first step, additional research regarding the integration of career development at the STEM undergraduate level is warranted (Abeysekera & Dawson, 2015).

MATERIALS AND METHODS:

The current study was conducted at a private, four-year college located in the United States. All research subjects were participants of the Advancing Interest and Motivation (AIM) for STEM Careers program. AIM for STEM Careers is a National Science Foundation-funded career development program designed to prepare students to enter the STEM workforce after graduation by utilizing research-based career preparation interventions. AIM for STEM Careers incorporates the Social Cognitive Career Theory as an underlying framework to guide programmatic interventions. The Social Cognitive Career Theory developed by Lent, Brown, and Hackett (1994) focuses on self-efficacy, outcome expectations, and goals. The overarching purpose of AIM for STEM Careers was to investigate the efficacy of utilizing an innovative theory-based career development model to improve STEM undergraduate students' career interests, career motivation, career self-efficacy, career outcome expectations, and employment outcomes. AIM for STEM Careers participants meticulously explored career options, developed resume and cover letter writing skills, mastered job interview skills, refined electronic job search techniques, examined leadership skills, and learned social media self-marketing and branding strategies. The STEM career development program also featured the use of reflective journals (Al-Rawahi & Al-Balushi, 2015) and professional seminars in which current STEM professionals conducted workshops to convey a realistic view of specific careers.

The thirty-one student participants in the current study consisted of Juniors and Seniors majoring in Biology, Mathematics, or Computer Information Systems. Data were collected over a three-year period (2014-2017) from AIM for STEM Careers participants at the same institution. Undergraduate student participants were required to read literature regarding the interview process, watch a 15-minute PowerPoint video designed to teach job interview preparation strategies, and take notes on the video before the in-class activities. The reading materials, career development video, and supplemental lecture notes were posted on the course management system. The face-to-face interaction featured a 5-minute review of the salient topics covered in the video followed by small group discussions in which participants discussed the major points introduced in the video. Each team leader then presented a summary of the discussion points to the entire class. To further reinforce and expand the topics presented in the video, students viewed an additional video in class that focused on advanced interview techniques. Next, students conducted peer-to-peer interviews using a professional interview rubric. STEM faculty evaluated each interview and provided useful feedback to each student. Students recorded interview improvement strategies in their journals for later review. Following the in-class activities, students completed a paper-based qualitative survey that contained open-ended questions.

The post-instructional survey employed in the study was framed around two central research questions and was designed to identify students' perceptions of the flipped classroom method. Specifically, survey items explored two major issues: knowledge acquisition and efficacy. Students were asked to respond to whether engagement with flipped teaching principles enhanced their understanding of job interview skills (e.g., knowledge acquisition). Additionally, survey items probed students' perceptions of the utility of employing flipped classroom techniques to improve students' understanding and application of additional STEM career development skills in the future (e.g., efficacy). Survey data was analyzed with respect to knowledge acquisition and efficacy using previously described qualitative analytical procedures (Ryan & Bernard, 2003). In brief, following data collection procedures a thorough review of students' open-ended responses was performed. Repetition of responses was used to identify conceptual relationships in the textual data. Data processing involved cutting and sorting of interrelated quotes and organizing student quotes into two thematic categories. An external reviewer examined the qualitative data to determine the validity of the data.

RESULTS:

Qualitative findings were compiled into two categories based on the overall objective of the study. Table 1 and Table 2 contain a representative sample of the results from the survey items.

Knowledge Acquisition:

Determination of whether students believed that the flipped technique enhanced their understanding of job interview skills was explored. A representative sample of the student responses regarding knowledge acquisition is shown in Table 1. Ninety-seven percent of the responses (30 out of 31) were overwhelmingly positive and indicated that the flipped classroom approach enhanced student comprehension of job interview skills. Most of the students agreed that they were more prepared for the in-class active learning tasks by watching the online video and taking notes on the video before classroom activities. One student, however, indicated that the online video merely reviewed topics learned in an earlier segment of the program but did reveal that helpful information was presented in the video, writing:

> "The video presentation covered many subjects previously addressed last semester. While the points may have refreshed other students' memories, I found them redundant overall. However, there were a few new tips that I found useful."

Table 1

Results from the knowledge acquisition inquiry items of the qualitative survey.
"I do feel that viewing the video presentation enhanced my understanding of interviewing skills. The video was very helpful with many tips."
"I felt as though I was well prepared for today's session because of the video presentation."
"I learned a lot of things that I should and shouldn't do on an interview."
"I believe that viewing the presentation prior to the session did, in fact, enhance my understanding."
"Viewing the video really improved my skills. I knew what to expect and was more confident speaking about the topics in class."
"Watching the STEM career video presentation on interviewing skills before class helped me a lot. I knew the information before the session but talking about it today made me think more about the information."
"I think the video prepared me for what to expect in today's session."
"The video helped me understand the interview process and how to be fully prepared for the actual job interview."

Another beneficial feature of the flipped classroom approach is that it takes advantage of students' unique learning styles. One student wrote:

> "I am a visual learner, and when something is presented to me through video, it gets my full and undivided attention and helps me understand the con-

cepts."

Efficacy:

Elucidation of whether students believed that the flipped model was an effective strategy to enrich undergraduate students' intellectual capacity to apply STEM career development skills in professional settings was ascertained. The majority of the students (97%) reported that the flipped classroom approach is a viable strategy to teach career development skills. Student responses indicated that using the flipped classroom method would lead to an increase in student collaboration and significantly improve preparation for in-class activities. One student explained:

> "Utilization of an online presentation before class is effective. Students have an advantage because they can form ideas and questions before class."

A major problem with the traditional lecture format is that not all students understand how to take notes effectively and many students fail to capture the most important points from face-to-face lectures given time restrictions. This problem is alleviated using the flipped classroom approach. One student aptly articulated a benefit to posting content videos online, writing:

> "Long term we will still have the video to learn from after the session has ended."

The broad goal here was to determine from the student's perspective if the use of flipped classroom strategies is a potentially useful approach that faculty and administrators may consider when developing future courses and extracurricular programs to target career development skills. Student survey data suggests that this technique should be explored further as a potential mechanism to improve students' career development skills. A representative sample of the student responses regarding the efficacy of the flipped model is shown in Table 2.

Table 2

Results from the efficacy inquiry items of the qualitative survey.
"This approach gives us more time during the session to learn something new."
"A video presentation before meeting helps students gain an understanding of relevant topics. The video presentation and classroom activities are an excellent strategy to enhance students' knowledge."
"I do feel that watching the online video prior to the meeting is effective. It helps me understand what we are going to discuss in class. I can do research on unfamiliar topics before class."
"The video presentation before the actual class session will help. It's at our convenience, and we can listen as much as we like or need to."
"I believe that viewing the information before the session is a great tactic. It allows for more interaction in class."
"By assigning a video or PowerPoint to view beforehand, it guarantees that each student has the same basic information. It also gives students time to think of any questions they may have before class."
"I feel that online video presentations are an effective strategy. It allows the student to know in advance what will be going on in class."
"I believe in the future having lecture notes online will save us time and help us better understand the material and be more prepared when we come to the session."

CONCLUSION:

Study findings are consistent with other reports on student perceptions of flipped classrooms (Entezari & Javdan, 2016; Ojennus, 2016) and indicate that utilization of the flipped classroom model had a positive impact on student comprehension of essential interview skills. Moreover, qualitative data revealed that students believe that content exposure via video presentations prior to in-class activities is a useful pedagogical approach to teaching career development skills in the future. This work has implications for department curricula. For example, STEM department administrators could design a series of informative online videos or webinars on job negotiation skills, electronic job search skills, career decision making, resume writing skills, career planning, interview skills, and career exploration. These videos could be sent to students via e-mail or posted on course-specific content management systems. Video engagement could be followed by campus-wide or course-related workshops to reinforce career development skills. Flipped teaching methods are particularly suited for teaching career development skills because the active learning activities and hands-on tasks that drive flipped lesson plans have been reported in the literature to enhance content mastery (Cheng, Ka Ho Lee, Chang, & Yang, 2017). The development of student learning rubrics for flipped classroom assignments would also aid in student assimilation and peer evaluation opportunities.

It should also be noted that several limitations exist in the study. First, while this study has a sufficient sample size (n=31) for qualitative research, the data reported in this article includes a non-random sample of participants from one academic institution. Stronger research designs may include investigations in which both the treatment group (flipped classroom) and control group (traditional classroom) were selected using randomized sampling strategies. Second, the flipped approach employed in this study was performed once during the nine-month, eleven session program. The other ten AIM for STEM Careers classroom sessions utilized the traditional lecture format to convey knowledge. Adding more flipped career development sessions in the study's intervention may have resulted in more meaningful responses due to greater exposure to the knowledge transmission technique.

While the findings of the current study are very encouraging, additional research investigations into the effects of employing flipped classroom strategies to expand career development skills of STEM undergraduates is necessary. This qualitative study is believed to be one of the first to employ the flipped classroom approach to teach fundamental STEM career development skills. It is envisioned that science education researchers will use the findings as a springboard to conduct more robust research studies to explore this issue and ultimately generate best practices that add to existing pedagogical frameworks designed to integrate career development-related skills into the STEM curriculum. To assist faculty in the utilization of this innovative pedagogical strategy, STEM undergraduate departments should consider implementing professional development opportunities to train faculty on introductory and advanced flipped instructional methods.

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